Early computed tomography or focused assessment with sonography in abdominal trauma: what are the leading opinions?

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Abstract: PURPOSE: The initial assessment of severely injured patients in the resuscitation room requires a systematic and quickly performed survey. Whereas the Advanced Trauma Life Support (ATLS(®))-based algorithm recommends focused assessment with sonography in trauma (FAST) among others, recent studies report a survival advantage of early whole-body computed tomography (WBCT) in haemodynamically stable as well as unstable patients. This study assessed the opinions of trauma surgeons about the early use of WBCT in severely injured patients with abdominal trauma, and abdominal CT in patients with isolated abdominal trauma, during resuscitation room treatment. METHODS: An online cross-sectional survey was performed over 8 months. Members of the Swiss Society for Surgery and the Austrian and German associations for trauma surgery were invited to answer nine online questions. RESULTS: Overall, 175 trauma surgeons from 155 departments participated. For haemodynamically stable patients, most considered FAST (77.6%) and early CT (82.3%) to be the ideal diagnostic tools. For haemodynamically unstable patients, 93.4% considered FAST to be mandatory. For CT imaging in unstable patients, 47.5% agreed with the use of CT, whereas 52.5% rated early CT as not essential. For unstable patients with pathological FAST and clinical signs, 86.8% agreed to proceed with immediate laparotomy. CONCLUSIONS: Most surgeons rely on early CT for haemodynamically stable patients with abdominal trauma, whereas FAST is performed with similar frequency and is prioritized in unstable patients. It seems that the results of recent studies supporting early WBCT have not yet found broad acceptance in the surgical community.

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Early computed tomography or focused assessment with sonography in abdominal trauma – what are the leading opinions?

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Purpose The initial assessment of severely injured patients in the resuscitation room requires a systematic and quickly performed survey. Whereas the Advanced Trauma Life Support (ATLS®)-based algorithm recommends focused assessment with sonography in trauma (FAST) among others, recent studies report a survival advantage of early whole-body computed tomography (WBCT) in haemodynamically stable as well as unstable patients.

This study assessed the opinions of trauma surgeons about the early use of WBCT in severely injured patients with abdominal trauma, and abdominal CT in patients with isolated abdominal trauma, during resuscitation room treatment.

Methods An online cross-sectional survey was performed over 8 months. Members of the Swiss Society for Surgery and the Austrian and German associations for trauma surgery were invited to answer nine online questions.

Results Overall, 175 trauma surgeons from 155 departments participated. For haemodynamically stable patients, most considered FAST (77.6%) and early CT (82.3%) to be the ideal diagnostic tools. For haemodynamically unstable patients, 93.4% considered FAST to be mandatory. For CT imaging in unstable patients, 47.5% agreed with the use of CT, whereas 52.5% rated early CT as not essential. For unstable patients with pathological FAST and clinical signs, 86.8% agreed to proceed with immediate laparotomy.

Conclusions Most surgeons rely on early CT for haemodynamically stable patients with abdominal trauma, whereas FAST is performed with similar frequency and is prioritized in unstable patients. It seems that the results of recent studies supporting early WBCT have not yet found broad acceptance in the surgical community.

Keywords Whole Body Imaging, Advanced Trauma Life Support, Ultrasonography, Abdominal Injuries

Introduction

The initial treatment of severely injured patients in the resuscitation room requires a quick and systematically performed assessment. In most trauma centers, this assessment is based primarily on Advanced Trauma Life Support (ATLS®) guidelines worldwide [1]. The ATLS® guidelines recommend a fast and priority-based physical examination and conventional diagnostics, such as conventional radiography (CR) of the thorax and pelvis as well as a focused abdominal sonography for trauma (FAST), which should precede the selective use of computed tomography (CT).

Huber-Wagner et al. have shown that the advantage of early surveillance using whole-body CT (WBCT) in severely injured, haemodynamically stable or unstable patients is an overall decrease in mortality rate [2, 3].

Abdominal injuries are common in polytrauma patients, who have a high overall mortality rate of 8% to 25% [4] and an increased risk of death with a diagnostic delay of 5 h [5]. We aimed to assess trauma surgeons' opinions about the use of early WBCT in severely injured patients with abdominal trauma or early abdominal CT in patients with isolated abdominal trauma, during resuscitation room treatment.

Material and methods

A cross-sectional study, based on an online survey, was performed in Austria, Switzerland and Germany. The questionnaire was available in German and French. This study was approved by the boards of the following expert associations and the chair of the working groups (German Trauma Society (DGU) – committee on Emergency Medicine, Intensive Care and Trauma Management (Sektion NIS) as well as working group Mission-, Disaster- and Tactical Surgery (AG EKTC), Austrian Trauma Society (ÖGU), Swiss Society for Surgery (SGC)). All registered members of these organizations (SGC: all active members, ÖGU: all members, DGU: members of the abovementioned section and working group) were invited to complete an online survey. The online survey was available through a password-protected online link for 8 months. The members were also asked to forward the online link to their colleagues.

The online survey was designed by the authors themselves and included nine questions (supplemental material). Four of the questions related to the importance of FAST and early abdominal CT or WBCT in haemodynamically stable and unstable patients with abdominal trauma, respectively. Two additional questions aimed to assess whether the surgeons perform a laparotomy in case of a conspicuous FAST in symptomatic haemodynamically stable and unstable patients. In the final two questions, the participants were asked if they believe that an early CT allows for better planning of surgery for haemodynamically stable and unstable patients with abdominal injury. The haemodynamic status was not further defined as no consistent definition exists.

The participants were given the following response options: ‘I agree completely’, ‘I agree’, ‘I do not agree’, ‘I disagree completely’ and ‘I have no opinion’. In the analysis, the response

options ‘I agree completely’ and ‘I agree’ were combined into one answer, and the responses ‘I do not agree’ and ‘I disagree completely’ were combined into another answer.

Finally, the participants were asked to prioritize and assort diagnostic and therapeutic options to deduce a treatment algorithm for a 44-year-old female driver who was admitted to resuscitation after an offset frontal collision at 30–40 km/h (Fig. 2). She was haemodynamically stable and exhibited only distinct pain in the lower abdomen with a circular bruise without peritonism and a soft abdomen. FAST showed suspect free fluid within the Koller pouch and a little fluid within the Douglas pouch.

In the same survey, seven additional questions were included to obtain information about the current treatment situation of patients with abdominal trauma according to recent changes in Germany, Austria and Switzerland. However, these analyses are not part of this article and will be reported separately.

The data were analysed using IBM® SPSS Statistics Version 22 (IBM Corp., Armonk, NY, USA). Considering that the analysis was descriptive, no tests of significance were performed. The graphic work was performed using Microsoft® Excel Version 14.3.6. (Microsoft Corp., Redmond, WA, USA).

This study was implemented in compliance with the present version of the World Medical Association Declaration of Helsinki 1964, the ICH-GCP guidelines and the current legal requirements. A waiver for this study was obtained from the local ethics committee. There are no conflicts of interest.

Results

In total, 175 trauma surgeons participated in the online survey. Seventeen were from Germany, 13 from Austria and 46 from Switzerland; 99 surgeons did not state their nationality.

In answer to the first question about whether FAST is an essential test for haemodynamically stable patients, 77.6% of the participants agreed, but 22.4% believed that FAST is not necessary in this setting. For the question about CT as a diagnostic tool, 82.3% of the trauma surgeons agreed with the use of an early CT in haemodynamically stable patients with abdominal trauma (Fig. 1A).

For the question about haemodynamically unstable patients, 93.4% of the participating trauma surgeons considered FAST to be necessary, but 6.6% did not agree with the use of FAST for the primary survey of haemodynamically unstable patients. An early CT was favoured by 47.5% of the participants, but 52.5% believed that an early CT is not essential in this setting (Fig. 1B).

A pathological FAST, defined by the appearance of relevant free fluid in haemodynamically stable patients combined with clinical signs, was considered by 10.8% of the participants to be justification for immediate operative treatment, but 85.4% did not consider an immediate laparotomy in this setting, and 3.8% had no opinion (Table 1).

A pathological FAST in haemodynamically unstable patients combined with clinical signs was considered by 86.8% of the participants to be justification for an immediate laparotomy. Twelve percent did not agree with the use of a laparotomy for this constellation, and 1.2% had no opinion (Table 1).

In answer to the question about preoperative planning and surgical tactics, 94.5% considered a CT to be a useful adjunct in haemodynamically stable patients. For haemodynamically unstable patients, 61.6% of the participants agreed that a CT allows for better planning of surgical tactics for operative treatment. The remaining 38.4% did not consider that CT allows for better planning (Table 2).

In the final section of the survey, participants were asked to state their prioritized treatment algorithm based on a short case about a haemodynamically stable patient with abdominal trauma, clinical symptoms of lower abdominal pain and suspect free fluid in FAST. Abdominal CT with intravenous contrast agent was the most frequent choice (61.7%) (Table 3). This was followed by either sonography controls or clinical controls (38.8%) and, if necessary, repeated blood tests (33.1%). The next most frequent options were abdominal CT with a triple contrast agent (25.8%), diagnostic laparoscopy (25.0%) and explorative laparotomy (25.2%). Most participants (57.0%) did not consider diagnostic peritoneal lavage.

Discussion

The purpose of the study was to assess surgeons' opinions about their use of early CT in patients with abdominal trauma during resuscitation room treatment.

Most of the participants rely on early CT in haemodynamically stable patients, whereas FAST is still performed with similar frequency. However, for haemodynamically unstable patients, almost all participants prefer FAST, whereas CT is performed by only half of the trauma surgeons. Regarding the planning of surgical tactics, less participants consider a CT in haemodynamically unstable patients which is most likely due to the additional time needed to perform a CT and thus the potential delay of a life-saving operation.

Although FAST is an integral part of the ATLS®-based algorithm, Huber-Wagner *et al*. have shown that WBCT during trauma room resuscitation significantly increases the survival rate in both haemodynamically stable and unstable major trauma patients [2, 3]. A randomized controlled trial reported a similar tendency for a relationship between severe injury and survival, although there was no significant difference between the study groups given and not given early WBCT [6]. Most patients with an initial work-up without WBCT receive a CT scan in the later course [6, 7]. In modern CT scanners, the risk of radiation exposure plays a minor role considering its benefits and the time to diagnosis [7, 8]. The risk of mortality from trauma is six times higher than the estimated risk of radiation-induced cancer mortality [9]. Additionally, new software algorithms such as iterative reconstruction techniques can help to reduce the radiation dose. Recent studies of polytrauma patients have shown that the combination of iterative reconstruction and reduced tube current produces a significantly lower radiation dose without deteriorating the diagnostic yield of the examination [10, 11].

Even though most participants used a CT scan for better surgical planning because of the documented increased survival rate with early CT scanning, it is surprising that they still

wanted to perform primary or additional FAST with similar frequency and mainly in haemodynamically unstable patients. This thinking is supported by the literature. According to the annual report of the TraumaRegister DGU® (TR-DGU), 76.9% of all resuscitation room admissions received a WBCT in 2015 [12] compared with the year before, when only 74.8% of all patients underwent a WBCT [13]. By contrast, FAST was performed in 81.7% of patients during resuscitation room treatment in 2015 [12] and in 80.7% of patients in 2014 [13]. Although FAST is performed to the same extent during the past few years, the additional use of WBCT seems to have become more and more an integral part of resuscitation room treatment.

The reasons for this apparent discrepancy between the need and demand may relate to the reservations about WBCT. The potential disadvantage of WBCT, especially for unstable patients, is the difficulty in escalating treatment if needed in the CT scanner room, where access to the patient is often poor and resuscitation equipment may not be readily available. One further argument is the potential delay because of the time needed to transport the patient to another part of the hospital. This is especially true in level-III and not qualified trauma centres, which were also included in our online survey. The time needed to perform WBCT is 3–6 minutes [14, 15], although this is highly dependent on local circumstances and the team organization and collaboration.

The contribution of time in the emergency department was reported by Clarke *et al*., who found that the probability of death increases by about 1% for each 3 min in hypotensive patients bleeding from abdominal injury that need laparotomy [16]. Barbosa *et al*. also reported that a delay in emergency laparotomy is associated with increased early and late in-hospital mortality [17]. In this context, most of the participants in our study supported the immediate use of laparotomy in haemodynamically unstable patients with a pathological FAST combined with clinical signs.

There are several arguments for WBCT and its ability to disclose the entire pattern of injuries, which allows the attending trauma team to act in an optimum, structured and prioritized way. A direct comparison of WBCT with CR and abdominal sonography by Albrecht *et al*. has shown that 80% of thoracic and 78% of abdominal injuries in trauma patients were missed, whereas only 3% were missed by WBCT [18]. While Albrecht *et al.* performed abdominal sonography, which sets out to make a clear diagnosis by a thorough assessment of all abdominal organs, the FAST protocol only aims to detect free intraabdominal fluid indicating organ lacerations. However, it has been reported that up to 34% of patients with abdominal organ injuries had no sonographically detected free fluid and tend to be missed by FAST [19]. While the specificity of FAST is consistently assessed between 98 and 99%, the reported sensitivity ranges from 22 to 78% depending on the study [20-24]. Regarding WBCT, its specificity is similar to that of FAST. The sensitivity of WBCT is certainly found to be higher and varies between 80-87% depending on the body region of interest. Thus, the residual risk of missing injuries by WBCT is 6% which emphasizes its benefit as a diagnostic tool in major trauma [25].

Blunt hollow viscus injuries, as included in the case in this survey, occur in less than 1% of all trauma admissions but tend to be underestimated with regard to morbidity and mortality statistics [5]. Considering that the physical examination may be unreliable and only 41.9% of patients present with tenderness, the CT becomes even more important for this type of injury [26]. A diagnostic delay of 5 h increases the risk of death after blunt hollow viscus injury [5], which supports the argument for the use of immediate CT which has a higher sensitivity to identify that kind of injury [25].

In terms of the time taken for resuscitation room treatment, Huber-Wagner *et al*. have shown that the closer the CT scanner is located to the trauma room, the higher the probability of survival, whereas distances more than 50 m have a significant negative effect on outcomes.

Thus, if performed quickly within a well-structured environment and by an organized trauma team, the delay should be very short. If the patient does not need emergency treatment, an additional FAST can be considered. This enables the junior trauma surgeon to acquire the necessary skills to perform a suitable and quick FAST. This is particularly important in the case of simultaneous patients in the resuscitation room, or a non-functioning CT, when the trauma surgeon must be capable of performing a FAST.

The online survey is limited by the low response rate of about 7%, although the response rate of online surveys is usually low, meta-analyses have reported average response rates of 34% and standard deviations of 15–22% for online surveys [27]. Furthermore blunt as well as penetrating abdominal trauma were included.

In conclusion, the results of our online survey show that most trauma surgeons agree with the use of early WBCT or abdominal CT in haemodynamically stable patients with isolated trauma, whereas FAST is prioritized in unstable patients. In accordance with the annual report of the TR-DGU, our data show that FAST is performed with similar frequency in haemodynamically stable and unstable patients. In our opinion, the increased survival rate in trauma patients receiving early WBCT outweighs any arguments against WBCT. Therefore, the goal should be to optimize the local circumstances so that immediate WBCT can be performed during resuscitation room management as far as possible in all trauma patients regardless of their haemodynamic status without any delay necessitated by FAST. The exception may be rare cases in extremis or in moderately injured patients, who are probably over-triaged for resuscitation room treatment. In the future these patients must be better identified.

Compliance with Ethical Standards

Conflict of interest: Lisanne Grünherz, Kai Oliver Jensen, Valentin Neuhaus, Ladislav Mica, Clément Werner, Bernhard Ciritsis, Christian Michelitsch, Georg Osterhoff, Hans-Peter Simmen and Kai Sprengel declare that they have no conflict of interest.

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from all individual participants included in the study.

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Legends for illustrations

Fig. 1. Response to question one to four: "FAST/WBCT or abdominal CT is an essential part for haemodynamically stable/unstable patients with abdominal trauma during primary resuscitation room treatment." Bar graphs demonstrate the use of FAST and WBCT/abdominal CT in haemodynamically stable (A) and unstable (B) patients. Whereas FAST and WBCT/abdominal CT are performed with similar frequency, FAST is prioritized in unstable patients.

Fig. 2. Photograph of the car accident involving a 44-year-old female driver who was admitted to the resuscitation room. She exhibited distinct pain in the lower abdomen with a circular bruise that can be seen in the inset on the right.

Figure 1

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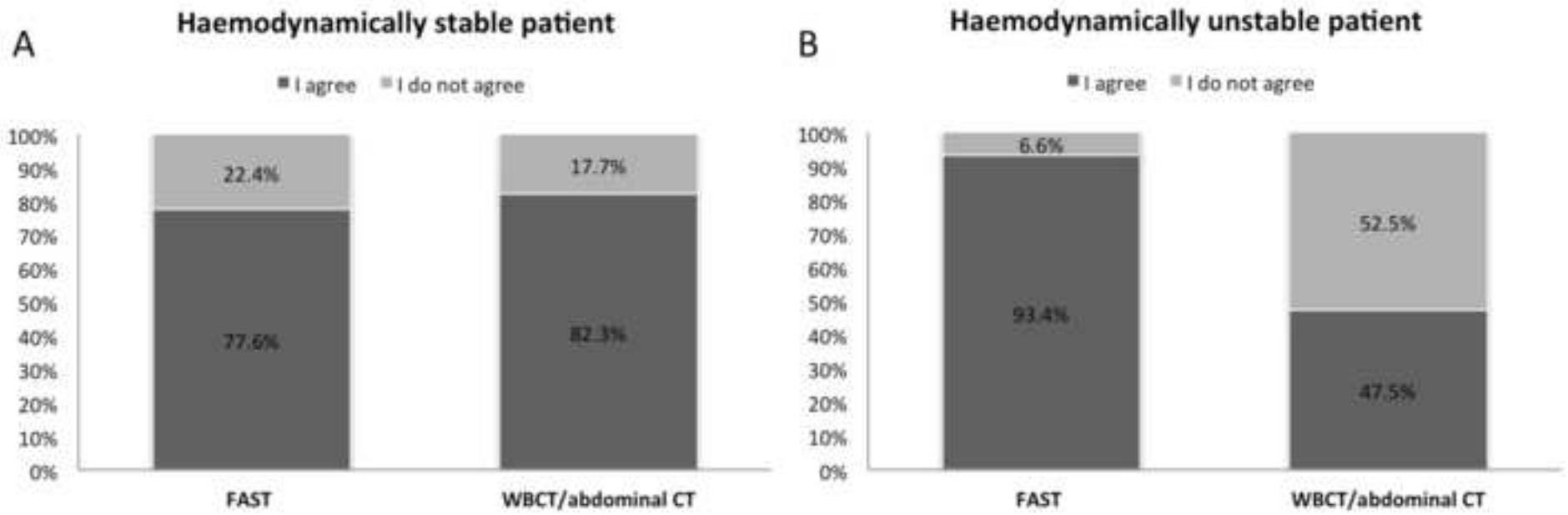

Figure 2

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Table 3 Prioritized treatment algorithm

Priority	Modality	Compliance
1	Abdominal CT, intravenous contrast	61.7%
2/3	Sonography Serial physical examination	38.8% 33.1%
4	Abdominal CT, triple contrast	25.8%
5/6	Laparoscopy Laparotomy	25.0% 25.2%
None	DPL	57.0%

DPL: Diagnostic peritoneal lavage.

Table 1

Table 1 Response to question five and six: “A pathological FAST combined with clinical signs in haemodynamically stable/unstable patients is a sufficient reason for an immediate laparotomy”

Haemodynamically	I agree	I do not agree	I have no opinion
stable	10,8%	85,4%	3,8%
unstable	86,8%	12,0%	1,2%

Table 2 Response to question seven and eight: “Early CT in haemodynamically stable/unstable patients with abdominal trauma allows for better planning of the surgery and tactic”

Haemodynamically	I agree	I do not agree
stable	94,5%	5,5%
unstable	61,6%	38,4%